

## Cosmic Chemistry: Planetary Diversity

## Stochastic Processes: Out of Chaos

### STUDENT REPORTING/DATA SHEETS 1-2

#### STUDENT REPORTING DATA SHEET

##### PART 1

Names: \_\_\_\_\_

\_\_\_\_\_

Predicted vs. observed outcomes of random chance events

| Marble Color Key         |  | Data Table 1        |
|--------------------------|--|---------------------|
| Marble Color Designation |  | Actual Marble Color |
| Color #1                 |  |                     |
| Color #2                 |  |                     |
| Color #3                 |  |                     |

- If you were to draw a single marble from the mixture, what is the probability that it will be a marble of color #1?
  - The favored outcome is drawing a marble of color #1. How many marbles of this color are in the mixture? →
  - The possible outcomes include drawing a marble of any color. How many marbles, regardless of color, are in the mixture? →
  - What is the probability of drawing a marble of color #1 on a given draw? Show your work and present the result as fraction(numerator/denominator) and as a decimal fraction.

Work:

Results:

2. If you withdrew 30 marbles from the mixture at random, how many of the marbles are expected (predicted) to be color #1 marbles? Show your work and present the result as a fraction (numerator/denominator) and as a decimal fraction.

Work:

Results:

3. What is the probability of drawing a marble of color #2 on a given draw? Show your work and present the result as a fraction (numerator/denominator) and as a decimal fraction.

Work:

Results:

4. If you withdrew 15 marbles from the mixture at random, how many of the marbles are expected (predicted) to be color #2 marbles? Show your work and present the result as a fraction (numerator/denominator) and as a decimal fraction.

Work:

Results:

5. What is the probability of drawing a marble of color #3 on a given draw? Show your work and present the result as a fraction (numerator/denominator) and as a decimal fraction.

Work:

Results:

6. If you withdrew 60 marbles from the mixture at random, how many of the marbles are expected (predicted) to be color #3 marbles? Show your work and present the result as a fraction (numerator/denominator) and as a decimal fraction.

Work:

Results:

Your Results

Data Table 2

| Trial #        | Color of Marble | Trial #        | Color of Marble | Trial #        | Color of Marble |
|----------------|-----------------|----------------|-----------------|----------------|-----------------|
| 1              |                 | 11             |                 | 21             |                 |
| 2              |                 | 12             |                 | 22             |                 |
| 3              |                 | 13             |                 | 23             |                 |
| 4              |                 | 14             |                 | 24             |                 |
| 5              |                 | 15             |                 | 25             |                 |
| 6              |                 | 16             |                 | 26             |                 |
| 7              |                 | 17             |                 | 27             |                 |
| 8              |                 | 18             |                 | 28             |                 |
| 9              |                 | 19             |                 | 29             |                 |
| 10             |                 | 20             |                 | 30             |                 |
| Color #1 Total |                 | Color #1 Total |                 | Color #1 Total |                 |
| Color #2 Total |                 | Color #2 Total |                 | Color #2 Total |                 |
| Color #3 Total |                 | Color #3 Total |                 | Color #3 Total |                 |

Observed Outcomes

Data Table 3

|                     | Trial # 1-10        | Trial # 11-20 | Trial # 21-30 | Total Trial #1-30 |
|---------------------|---------------------|---------------|---------------|-------------------|
| <b>Your Data</b>    | <b># of Marbles</b> |               |               |                   |
| Color #1            |                     |               |               |                   |
| Color #2            |                     |               |               |                   |
| Color #3            |                     |               |               |                   |
| <b>Classmate #1</b> | <b># of Marbles</b> |               |               |                   |
| Color #1            |                     |               |               |                   |
| Color #2            |                     |               |               |                   |
| Color #3            |                     |               |               |                   |
| <b>Classmate #2</b> | <b># of Marbles</b> |               |               |                   |
| Color #1            |                     |               |               |                   |
| Color #2            |                     |               |               |                   |
| Color #3            |                     |               |               |                   |

Proportional Outcomes

Data Table 4

| Data Source                           | Proportion of Color #1 | Proportion of Color #2 | Proportion of Color #3 |
|---------------------------------------|------------------------|------------------------|------------------------|
| <b>Your Data</b>                      |                        |                        |                        |
| Trial #1-10                           |                        |                        |                        |
| Trial #11-20                          |                        |                        |                        |
| Trial #21-30                          |                        |                        |                        |
| <b>Total Trial #1-30</b>              |                        |                        |                        |
| <b>Classmate #1</b>                   |                        |                        |                        |
| <b>Total Trial #1-30</b>              |                        |                        |                        |
| <b>Classmate #2</b>                   |                        |                        |                        |
| <b>Total Trial #1-30</b>              |                        |                        |                        |
| <b>All Data Total<br/>Trial #1-90</b> |                        |                        |                        |

7. Answer the following questions using the values presented in DATA TABLE #4.

- a) Describe how the ratios of the three colors of marbles that you observed were different from those you calculated using Total of All Data (last line, DATA TABLE #4) observations.
- b) Describe which of these value sets is the more reliable estimate of the actual ratio of marbles. Include a reason why you reached this conclusion.
- c) Based on the mean of all observations, what is the probability that you randomly would withdraw a marble of color #1?

STUDENT REPORTING DATA SHEET

PART 2

Names: \_\_\_\_\_

\_\_\_\_\_

Modeling one possible type of planetary formation process.

[Measuring Cup = 1/3 cup]

Data Table 5

| Observation Number      | Number of Color #1 Marbles | Number of Color #2 Marbles | Number of Color #3 Marbles | TOTAL Number of Marbles |
|-------------------------|----------------------------|----------------------------|----------------------------|-------------------------|
| #1                      |                            |                            |                            |                         |
| #2                      |                            |                            |                            |                         |
| #3                      |                            |                            |                            |                         |
| #4                      |                            |                            |                            |                         |
| #5                      |                            |                            |                            |                         |
| SUM of All Observations |                            |                            |                            |                         |
| OBSERVED RATIO          |                            |                            |                            |                         |

[Measuring Cup = 1/2 cup]

Data Table 6

| Observation Number      | Number of Color #1 Marbles | Number of Color #2 Marbles | Number of Color #3 Marbles | TOTAL Number of Marbles |
|-------------------------|----------------------------|----------------------------|----------------------------|-------------------------|
| #1                      |                            |                            |                            |                         |
| #2                      |                            |                            |                            |                         |
| #3                      |                            |                            |                            |                         |
| #4                      |                            |                            |                            |                         |
| #5                      |                            |                            |                            |                         |
| SUM of All Observations |                            |                            |                            |                         |
| OBSERVED RATIO          |                            |                            |                            |                         |

[Measuring Cup = 1 cup]

Data Table 7

| Observation Number      | Number of Color #1 Marbles | Number of Color #2 Marbles | Number of Color #3 Marbles | TOTAL Number of Marbles |
|-------------------------|----------------------------|----------------------------|----------------------------|-------------------------|
| #1                      |                            |                            |                            |                         |
| #2                      |                            |                            |                            |                         |
| #3                      |                            |                            |                            |                         |
| #4                      |                            |                            |                            |                         |
| #5                      |                            |                            |                            |                         |
| SUM of All Observations |                            |                            |                            |                         |
| OBSERVED RATIO          |                            |                            |                            |                         |

- Answer the following questions using the values in Data Tables #5, #6, and #7:
  - Which of the three ratios of marbles most closely matches the predicted ratio of marbles?
  - Using the sum of all observation values in Data Table #5, predict the expected ratio of marble colors if a 1-cup measuring cup was used [show your calculations].
  - How does the predicted ratio you just calculated compare with the OBSERVED RATIO values in Data Table #7?
  - Give possible reasons for the differences in the observations.
  - Using the sum of all observation values in Data Table #6, predict the expected ratio of marble colors if a 1-cup measuring cup was used [show your calculations].
  - How does this predicted ratio you just calculated compare with the OBSERVED RATIO values in Data Table #7?
  - Give possible reasons for the differences in the observations.
- Assume that:
  - Each of the marble colors models a different chemical element
  - Each chemical element has the atomic mass unit value of its marble color (such as 1, 2, or 3 for marble color #1, marble color #2, or marble color #3, respectively)
  - The original mixture of marbles models the ratio of these elements in the remnants of the solar nebula
  - Scooping the marbles using differently sized-measuring cups models the formation of planets of different sizes
- Using this model, answer the following questions:
  - Describe how the elemental composition of three planets differ.
  - Explain the source of variability that led to the difference in elemental composition among the planets in this case.
  - What factors, other than the differences between predicted and observed outcomes of random chance events, could account for the differences in the elemental composition of the three planets?